Application of nutrient intake values (NIVs)

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Abstract

The process of applying nutrient intake values (NIVs) for dietary assessment, planning, and implementing programs is discussed in this paper. In addition to assessing, monitoring, and evaluating nutritional situations, applications include planning food policies, strategies, and programs for promotion of optimal nutrition and preventing and treating malnutrition (both over- and undernutrition). Other applications include nutrition education, food and nutrient legislation, marketing and labeling, research, product development, food procurement and trade (import and export), food aid, and therapeutic (clinical) nutrition. Specific examples of how NIVs are used to develop food labels, fortification policies, and food-based dietary guidelines are described. Applications in both developed and developing countries are also described. In summary, NIVs are the scientific backbone of all aspects of nutrition policy in countries and regions worldwide.

Key words: Diet assessment, diet planning, dietary guidelines, food fortification, food labeling, nutrient recommendations

Introduction

As mentioned elsewhere in this supplement to the Food and Nutrition Bulletin [1–3], harmonization of the process and methods to establish nutrient intake values (NIVs) provides a common basis for the uses and applications of these values across countries and regions of the world. In the paper by Murphy et al. [3], methods for using NIVs to assess nutritional status, policy planning, and development of strategies and programs contributing to optimal nutritional health of individuals, groups, and populations are described. The main objectives of this paper are to highlight some of the applications of NIVs, to show how the new proposed terminology and methods of derivation improve the ability to develop realistic, achievable nutrient goals in developed and developing countries, and to provide specific examples of how the NIVs can be used to establish food labels, make decisions about fortification, and derive food-based dietary guidelines.

The terms used to describe the components of a set of NIVs are as follows. The framework used to derive these values is described in the paper by King et al. [2].

Nutrient intake values (NIVs) is the umbrella term for a set of specific nutrient standards. At least three different values should be derived: an average nutrient requirement (ANR), an individual nutrient intake level (INL), and an upper nutrient level (UNL). Detailed definitions of these terms follow. The US/Canadian set of nutrient standards is called the dietary reference intakes (DRIs); in Britain they are called dietary reference values (DRVs).

The average, or mean, nutrient requirement (ANR) is estimated from a statistical distribution of requirements for a specific criterion (e.g., to prevent a deficiency or maintain body stores) for specific life-stage (age) and gender (sex) groups. In the US/Canadian and UK recommendations, this value is called the estimated average requirement (EAR), while the European Communities use the term average requirement intake (ARI).

The individual nutrient intake level (INL) is the...
recommended intake for all healthy individuals in a specific subpopulation. If set at 2 SD above the ANR, the INLₓ would be INL₉₈. It could be set lower if food policies or food supplies in a country or region do not permit achieving an intake at the 98th percentile for all healthy individuals. Other terms used to describe this value include the recommended dietary allowance (RDA) by the United States and Canada, the reference nutrient intake (RNI) by the United Kingdom, and the population reference intake (PRI) by the European Communities.

The upper nutrient level (UNL) is the highest level of intake that is likely to pose no risk of adverse health effects for almost all individuals in a specific life-stage and sex group. The USA/Canada developed a comparable term, which was called the upper tolerable nutrient intake level (UL).

**General framework**

NIVs are used in many different ways to promote optimal nutrition and to prevent and treat under- and overnutrition. Figure 1 illustrates the “pathway” of applications, showing how planning of nutritional policies, strategies, programs, regulatory frameworks, legislation, etc. should be based on the results of assessment and surveillance of nutritional status. Policies and planning, usually done by the government, lead to nutritional actions, interventions, or programs. The outcomes of these interventions should be evaluated and monitored on a regular basis to influence adjustments in planning if necessary. NIVs are used for all these steps in the assessment, planning, and evaluation process for both groups and individuals.

**Specific applications of NIVs**

A brief overview of the many different applications [4] of NIVs affecting nearly all aspects of food and nutrition policy and practice is described below. Specific descriptions of how the NIVs are used to derive food labels, make decisions about food fortification, and develop food-based dietary guidelines are also provided.
Nutritional monitoring programs generally involve an assessment of nutritional risks, identification of the gaps or excesses in nutrient intakes of individuals or groups, planning of appropriate interventions, and monitoring of the results. NIVs are used to identify nutrient inadequacies or excesses of various population groups or individuals; they can also be used to estimate the percentage of the population at risk for inadequate or excessive intakes and to determine the impact of nutrition programs on the prevalence of low or excessive intakes over time in the target populations and/or subgroups. For example, NIVs were used to evaluate the prevalence of low nutrient intakes among the participants in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in the United States [5]. The NIVs can also be used to evaluate the adequacy of a country’s or region’s food supply to meet the nutritional needs of the population and to examine trends in nutrient consumption over time.

**Nutrition policy, regulatory frameworks, legislation, strategy, and program planning**

Although food and nutrition policy often is a national responsibility, many countries depend on international organizations for guidance in formulating policies. These organizations include the World Bank and several United Nations organizations and agencies such as the World Health Organization (WHO), the Food and Agriculture Organization (FAO), the United Nations International Children’s Fund (UNICEF), the United Nations Educational, Scientific, and Cultural Organization (UNESCO), the United Nations University (UNU), the United Nations Development Program (UNDP), the United Nations World Food Programme (WFP), and others. All of these organizations use NIVs to plan, develop, and define policies that support food and nutrition security and safety at all levels, including individuals, households, communities, vulnerable groups within communities, and whole populations. For example, the program for feeding refugees developed by the FAO is based on NIVs.

**Food and nutrition interventions**

NIVs are used to plan and design interventions such as food fortification and supplementation programs, school nutrition programs, changes in the food supply, and other interventions to improve the nutritional status of individuals and groups. NIVs are also frequently used to evaluate the eligibility for specific programs and to monitor the outcomes of interventions. Specific uses of NIVs include planning meals, food purchases, and budgeting decisions for intervention programs. NIVs can be used to determine if the goals of the interventions are reached by comparing postintervention intakes of individuals and groups with values collected at baseline; failure to reach goals provides a basis for modifying the intervention program. Use of the ANR for assessing the impact of a program in specific individuals will provide quantitative data on the number of individuals with improved nutrient intakes. Before having an ANR for estimating prevalence of adequacy, program planners could only make qualitative statements about the effectiveness of the intervention.

**Food and nutrition education**

NIVs are used per se or translated into food-based dietary guidelines to educate individual consumers, health personnel, or groups of people on how to select optimal diets to meet nutritional requirements, how to interpret nutrition labels on food products, and how to evaluate nutrition advertising in the media. Thus, NIVs should provide the basis for all food and nutrition education programs in a country or region. For example, the first step in deriving any nutrition education program should be an assessment of nutrient shortfalls and excesses among the target population. Most countries and regions develop food-based dietary guidelines (pyramids, plates, etc.) to assist individuals in making good food choices. A detailed description of how to translate NIVs into food-based guidelines follows in the next section. The goal should be to provide guidance for how populations can meet the INLx without exceeding the UNL.

**Nutrition research**

NIVs are used to design research studies for determining nutrient functions, the relationships between nutrient intakes and health or disease, nutrient–nutrient interactions, nutrient–gene interactions, and other nutrient issues. For example, NIVs are used to assess the association between the intake of nutrients and/or other dietary components and the risk of cardiovascular disease, cancer, diabetes, and other long-term disorders in clinical and epidemiologic studies. Data from large-scale population studies have been used to set standards of intake for the percentage of energy from carbohydrate, protein, and fat to reduce the risk of chronic disease.

**Product development**

Using specific, quantitative information on the effect of specific nutrients or food components on health outcomes, NIVs may be used to design and develop new technologies and new food products with health
Dietary reference standards are used to label and food labels based on dietary guidelines, food fortification, and derivation of food-based dietary guidelines. Specific uses of NIVs for food labeling, food fortification, and derivation of food-based dietary guidelines.

**Therapeutic (clinical) nutrition/dietetics**

Although NIVs are derived for healthy people, these values are frequently used as the basis for planning therapeutic diets for patients suffering from various diseases, since no other standard is available. Adjustments in the values are made whenever possible, using information about the disease process and nutrient metabolism. For example, certain adjustments may be made in the diets of individuals suffering from infections in order to enhance their immune function [7]. Diet manuals of hospitals and professional medical organizations and societies often provide the criteria used to modify the intake of specific nutrients in menus for patients.

**Food procurement for institutions and groups**

Institutions such as schools, hostels, nursing homes, the military, prison services, etc., use NIVs for planning menus and procuring foods. The INL should be used as the basis for menu planning. However, since individuals and groups fed in institutions vary widely in age, lifestyle habits (e.g., smoking), physical activity, and nutritional and health status, the menu planners will need to select the standard most appropriate for the group as a whole. Ideally, nutrient intakes should be carefully monitored to ensure that practically all of the individuals have intakes above the EAR and very few exceed the UNL.

**Food import, export, and subsidies**

Governments, agencies, and businesses (industry) use NIVs to motivate and formulate policies and actions regarding food import, export, and subsidies. The paper by Ramaswamy and Viswanathan [8] in this issue outlines the importance of using a set of standards with a common basis in international trade.

**Specific uses of NIVs for food labeling, food fortification, and derivation of food-based dietary guidelines**

**Food labels**

Dietary reference standards are used to label and market products by comparing the nutrient composition of the product (usually per 100 g or serving size) with recommended intakes.

In most instances the INL_{98} (RDAs, RNIs, or PRIs) are used to compare the contribution of the particular product with a reference standard, often expressed as a percentage. For example, in the United States the reference standard for vitamin C is 60 mg/day, so a glass of orange juice that provides about 95 mg of vitamin C would be labeled as having 160% of this standard. However, a recent committee of the Institute of Medicine recommended that the EAR (ANR), rather than the RDA, be used as the nutrient standard, because this standard is the best estimate of a consumer’s actual requirement [9]. Others have argued that the RDA should continue to be the basis of the standard for food and dietary supplement labels, because this higher standard should be adequate for almost all healthy individuals and is more consistent with the educational objectives of the food label [10].

Food labels also serve as a basis for nutrient content claims and in some products for health claims. For nutrient content claims on the food label, such as a claim that the food is a good source of a particular nutrient, many countries legislate the minimum percentage of the INL_{98} (RDA or other standard) that a portion or serving usually consumed should provide. Likewise, for a health claim, for example one with regard to lowering neural tube defects, the food or product must be a good source of folate.

The food industry often uses food labels to promote the nutritional benefits of products. The challenge is to harmonize the specific nutrient reference standard to be used, the guidelines for classifying a product as a good source of the nutrient, and the circumstances that will allow a health claim. With increasing international trade, developing comparable practices in different countries in a way that will be understood by most consumers will become more urgent.

**Food fortification**

Food fortification is a very cost-effective intervention to address micronutrient deficiencies. Types of fortification include mass (mandatory) fortification of staples, market-driven (voluntary), as in the addition of micronutrients to ready-to-eat cereals, or targeted to special groups in the population such as complementary foods for young children. The use of NIV’s is necessary to assess the prevalence of inadequate intakes of specific nutrients and to calculate appropriate levels of fortification. Specifically, using food intake data from a relatively small number of individuals from each population group of concern, the prevalence of intakes below the ANR is calculated. Then the effect of adding different levels of fortificant nutrients to one or more staple foods can be simulated, with the opti-
Food-based dietary guidelines

Food-based dietary guidelines translate scientific information on nutrient requirements and dietary characteristics that promote good health into recommendations and advice for the general public. Thus, food-based guidelines are the backbone of nutrition education efforts throughout the country, and they also reflect the nutrition policy of a country.

The NIVs for a country that include the three components (ANR, INL$_x$, and UNL) can be used to develop food-based dietary guidelines and patterns to assist the general public in selecting a diet that meets their nutrient needs. Often food-based dietary guidelines emphasize the importance of consuming a variety of nutrient-dense foods and beverages within and among the basic food groups used in the country, i.e., fruits; vegetables; grains; meat, fish, poultry, beans, and nuts; and fats and oils. Specific food patterns quantify the amounts needed from each food group for individuals in various age and sex groups. A food pattern can be developed using the following five-step process. This process was developed by the US Department of Agriculture and used to develop the new My Pyramid, which shows Americans how to meet their RDAs [12].

1. **Establish nutrition goals for the food pattern.** The nutrient goals should be the INL$_x$ values for vitamins, minerals, electrolytes, and macronutrients, as developed by the country or region.

2. **Establish energy levels.** Modifications of the food pattern can be developed for energy levels that cover the needs of all members of the population above 2 years of age. For example, 12 different food patterns could be developed with energy values ranging from 1,000 to 3,200 kcal/day in 200-kcal increments.

3. **Assign nutrient goals to each specific energy level.** The nutritional values assigned to each energy level are the INL$_x$ values for age and sex groups that most closely match that specific energy level. For example, the 1,800 kcal/day level might be the highest INL$_x$ value recommended for women aged 31 to 50 years, men and women aged 9 to 13 years, and women aged 14 to 18 years.

4. **Assign a nutrient value for each food group and subgroup.** The nutrient values for food groups and subgroups used in My Pyramid were developed in the following way [12]. The nutrient values assigned to each food group (i.e., fruits, milk, meat and beans, whole grains, enriched grains, dark-green leafy vegetables, orange vegetables, legumes, starchy vegetables, and other vegetables) were the weighted average nutritional value of foods consumed by Americans within that group based on the results of the nationwide food-consumption surveys (the USDA Continuing Survey of Food Intakes by Individuals, 1994-96). For example, broccoli constitutes 53% of the dark-green leafy vegetables consumed, spinach 20%, and other vegetables the remaining 27%. Therefore, the nutritional value of dark-green vegetables was 0.53 for broccoli, 0.20 for spinach, and 0.27 for other foods. The form of milk and meat with the lowest fat content was used exclusively. Thus, fat-free milk was the single food item used for the dairy group.

5. **Determine the daily intake amounts for each food group or subgroup.** The amounts of each food group or subgroup were increased or decreased in an iterative manner until the pattern for each energy level meet its nutritional goal (i.e., INL$_x$) or came within a reasonable range.

Use of NIVs in developing countries

NIVs may be particularly useful to policy makers in developing countries for reducing the prevalence of nutrient inadequacies and preventing excessive intakes of other food components. The nutrition transition currently occurring in many developing countries [13] provides evidence that both underconsumption and overconsumption are present within the same population. An advantage of the NIVs, described in the paper by King et al. [1] in this issue, is that individual countries can determine their own specific nutrient goals within the context of the entire harmonization process. For example, if animal source foods are scarce in a developing country, policy makers may decide to set the INL$_x$ for zinc and iron at 1 SD above the average nutrient level (INL$_{95}$) instead of 2 SD (INL$_{98}$).

The general applications of nutrient standards for populations living in developing countries (i.e., dietary assessments, developing targeted intervention programs such as food aid programs, and evaluating or monitoring these programs) parallel similar applications in developed countries, although the scale and scope of the programs may differ. Many uses of the NIVs in feeding and intervention programs require making adjustments in the measurements of nutrient intake to account for day-to-day variation. These adjustments are usually made by using 2 or more days of estimated intakes from the target population. Although diets in developing countries may appear to be monotonous, it cannot be assumed that it is unnecessary to make adjustments for day-to-day variation; the food supply is often less predictable than in wealthier populations. Thus, a similar adjustment protocol should be followed in all populations [4].
The high prevalence of micronutrient deficiencies or the widespread prevalence of disease, such as HIV/AIDS, will probably have an impact on the actual amounts of the NIVs established in some of the developing countries. For example, countries with a high prevalence of HIV/AIDS may want to set different standards for nutrients known to influence immune function. Also, typical foods consumed in these countries may be high in phytate, which reduces the bioavailability of minerals for absorption. Ideally, NIVs should be derived from studies of the nutrient requirements in representative individuals consuming typical diets from the population in each country. If experimental data on nutrient requirements are not available from the country’s population, extrapolations can be made from published data of similar populations in other countries or regions.

Thus, the basic uses of NIVs are similar in developed and developing countries, but the specific application may require unique decisions about goals and policies as well as specific adjustments in the actual quantities of nutrients recommended based on the food supply and general health of the population.

Potential users of NIVs

There is a wide variety of potential users of NIVs, including international organizations such as UN agencies; nongovernmental organizations (NGOs); governments (from local to district to national level); researchers from the disciplines of nutrition, foods, medicine, biochemistry, policy, etc.; health professionals, including doctors, dieticians, nutritionists, nurses, etc.; the food industry; institutions (hostels, homes, schools, the military, prisons, etc.); and caterers and restaurateurs, as well as the public (individual consumers and small community groups). The UN agencies and organizations, NGOs, and governments use the nutrient-based dietary standards to identify nutrient requirements of populations to formulate food and nutrition policy for food aid, supplements, rationing, fortification, education, legislation, export and import of foods, and subsidies for certain foods or for producers of foods [14]. The food industry uses these standards to develop new food products that will respond to consumers’ needs for healthy choices and to market foods by using nutrient labeling. Health professionals and researchers may use the nutrient-based reference standards to assess the nutritional adequacy of diets, plan appropriate corrective interventions, and evaluate these interventions [14]. Institutions, caterers, and restaurateurs use the reference standards to assess food requirements, make procurement decisions, and plan menus. Consumers use the standards to interpret the nutrition information provided by the media and on food labels.

It is the responsibility of nutrition scientists involved in establishing NIVs to inform and educate the users about the appropriate interpretation of the NIVs and the appropriate use of the three different values (ANR, INL, and UNL). It is also the responsibility of those doing nutrition interventions, such as food fortification, to use the NIVs because these interventions have a direct effect on public health.

Conclusions

Expanding the NIVs to include an average nutrient requirement (ANR), an individual nutrient level (INL), and an upper nutrient level (UNL) expands the potential uses of these standards. The three components of a set of NIVs are derived from a distribution of requirements for a nutrient for a specific function. The standards can be used for a broad range of functions—from the assessment, surveillance, monitoring, and evaluation of nutritional situations, to informing the formulation of policy and strategies, to planning and designing a large variety of appropriate interventions, and to evaluating the outcomes of these interventions in individuals and groups. A number of potential users, ranging from international organizations, NGOs, governments, industry, health professionals, to institutions and individual consumers, have been identified. All of these users should be targeted in educational efforts to promote the correct use of the NIVs.

References

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